

Claims:

1. A running tool and lockdown sleeve assembly for axially fixing upward movement of a tubular hanger with respect to a subsea wellhead housing, the tubular hanger connected to a tubular string extending downward from the subsea wellhead housing into the well, the subsea wellhead housing including an outer latching profile, the assembly comprising:

the running tool including (a) a tool latching mechanism for axially connecting the running tool to the subsea wellhead housing, (b) a tool force applicator for exerting a downward setting force after the tool latching member connects the tool to the subsea wellhead housing, and (c) a sleeve latching applicator for moving a sleeve latching mechanism;

a lockdown sleeve having a generally cylindrical outer surface and a central bore, the sleeve latching mechanism moveable in response to the sleeve latching applicator for axially connecting the lockdown sleeve to the subsea wellhead housing; and

a seal for sealing between the lockdown sleeve and one of the tubular hanger and the wellhead housing in response to the downward force.

2. An assembly as defined in Claim 1, wherein the tool latching mechanism effects radial movement between latched and unlatched positions in response to axial movement of an actuator.

3. An assembly as defined in Claim 1, wherein the seal is set by downward motion of the lockdown sleeve relative to the subsea wellhead housing.

4. An assembly as defined in Claim 1, wherein the seal is carried to the subsea wellhead housing on a lower end of the lockdown sleeve.

5 5. An assembly as defined in Claim 1, wherein the sleeve latching mechanism is provided at an upper end of the lockdown sleeve.

6. An assembly as defined in Claim 1, wherein the running tool is hydraulically actuated.

10 7. An assembly as defined in Claim 1, wherein the subsea wellhead housing includes an inner profile to receive the sleeve latching mechanism to axially connect the lockdown sleeve of the wellhead housing.

8. An assembly as defined in Claim 1, wherein the sleeve latching mechanism is a split ring.

15 9. An assembly as defined in Claim 1, wherein the running tool includes a packer and a fluid passageway for testing sealing integrity of the seal.

10. An assembly as defined in Claim 1, wherein an axially moveable piston within the running tool moves the latching applicator to connect the lockdown

sleeve to the subsea wellhead housing.

11. An assembly as defined in Claim 1, wherein the seal includes a metal-to-metal seal.

5 12. An assembly as defined in Claim 1, wherein the seal includes an elastomeric seal.

13. An assembly as defined in Claim 1, wherein the lockdown sleeve has an inner profile for receiving a latching mechanism from another tool.

10 14. An assembly as defined in Claim 13, wherein the sleeve includes a sealing profile for sealing engagement with a sealing member positioned within the sleeve.

15. An assembly as defined in Claim 1, wherein a tubular hanger is a casing hanger.

15 16. A running tool and lockdown sleeve assembly for axially fixing upward movement of a casing hanger with respect to a subsea wellhead housing, the casing hanger connected to a casing string extending downward from the subsea wellhead housing into the well, the subsea wellhead housing including an outer latching profile, the assembly comprising:

the running tool including (a) a tool latching mechanism for axially connecting

the running tool to the subsea wellhead housing, (b) a tool force applicator for exerting a downward setting force after the tool latching member connects the tool to the subsea wellhead housing, and (c) a sleeve latching applicator for moving a sleeve latching mechanism;

5 a lockdown sleeve having a generally cylindrical outer surface and a central bore, the sleeve latching mechanism movable in response to the sleeve latching applicator for axially connecting the lockdown sleeve to the subsea wellhead housing; and

10 a seal for sealing between the lockdown sleeve and the tubular hanger in response to the downward movement of the lockdown sleeve in response to the downward setting force.

17. An assembly as defined in Claim 16, where the seal is carried to the subsea wellhead housing on a lower end of the lockdown sleeve.

15 18. An assembly as defined in Claim 16, wherein the sleeve latching mechanism is provided at an upper end of the lockdown sleeve.

19. An assembly as defined in Claim 16, wherein the running tool is hydraulically actuated.

20 20. An assembly as defined in Claim 16, wherein the subsea wellhead housing includes an inner profile to receive the sleeve latching mechanism to axially connect the lockdown sleeve of the wellhead housing.

21. An assembly as defined in Claim 16, wherein the sleeve latching mechanism is a split ring.

22. An assembly as defined in Claim 16, wherein the running tool includes a fluid passageway through the running tool for relieving fluid pressure.

5 23. An assembly as defined in Claim 16, wherein an axially moveable piston within the running tool moves the latching applicator to connect the lockdown sleeve to the subsea wellhead housing.

24. An assembly as defined in Claim 16, wherein the seal includes a metal-to-metal seal.

10 25. An assembly as defined in Claim 16, wherein the lockdown sleeve has an inner profile for receiving a latching mechanism from another tool.

26. A method of fixing a lockdown sleeve to a subsea wellhead housing for axially fixing upward movement of a tubular hanger with respect to the subsea wellhead housing, the tubular hanger connected to a tubular string extending
15 downward from the subsea wellhead housing into the well, the subsea wellhead housing including an outer latching profile, the method comprising:

providing a running tool including (a) a tool latching and unlatching mechanism for axially connecting the running tool to the subsea wellhead housing, (b) a tool force applicator for exerting a downward setting force after the tool

latching member connects the tool to the subsea wellhead housing, and (c) a sleeve latching applicator for moving a sleeve latching mechanism;

providing a lockdown sleeve having a generally cylindrical outer surface and a central bore;

5 providing a seal for sealing between the lockdown sleeve and one of the tubular hanger and the wellhead housing in response to the downward force; and

lowering the running tool, the lockdown sleeve and the seal in open water to the subsea wellhead housing;

locking the tool to the outer latching profile of the wellhead housing;

10 applying a force to set the seal;

moving the sleeve latching mechanism to latch the lockdown sleeve to the wellhead housing; and

retrieving the tool to the surface with the lockdown sleeve fixed to the subsea wellhead housing.

15 27. A method as defined in Claim 26, wherein the tool latching and unlatching mechanism effects radial movement between latched and unlatched positions in response to axial movement of an actuator.

28. A method as defined in Claim 28, wherein the seal is set by downward motion of the lockdown sleeve relative to the subsea wellhead housing.

20 29. A method as defined in Claim 26, wherein the seal is carried to the subsea wellhead housing on a lower end of the lockdown sleeve.

30. A method as defined in Claim 26, wherein the running tool is hydraulically actuated.

31. A method as defined in Claim 26, wherein the running tool is lowered to the wellhead housing on a wireline.

5 32. A method as defined in Claim 26, wherein the running tool is lowered into the well by an ROV.

33. A method as defined in Claim 26, wherein the running tool includes a packer and a fluid passageway for testing sealing integrity of the seal pressure.

10 34. A method as defined in Claim 26, wherein the sleeve has an inner profile for receiving a latching mechanism from another tool.